

# TASO introduction to pre and post-test design: conducting a paired *t*-test using Excel

This document outlines how to conduct a paired *t*-test on pre- and post-intervention survey items. This type of analysis is also called pretest posttest analysis and is used to determine whether there is a significant difference between the means of your pre-intervention scores and your post-intervention scores. Ideally, we want our post-intervention scores to be higher to show that the intervention has had a positive effect on student's attitudes towards HE. To carry out a paired *t*-test, follow the steps below. These steps have been conducted on some fictitious data for the purpose of this guidance.

## 1. Ensure that the Data Analysis ToolPak is installed



If you cannot see the Data Analysis package (as above), click the 'File' tab on the top-left of your Excel spreadsheet and then click 'Options' on the bottom-left. Click 'Add-Ins'. Under 'Manage' at the bottom, choose 'Excel Add-ins' from the drop-down list, and click 'Go'. On the pop-up that appears, tick 'Analysis ToolPak' and click 'OK'.

## 2. Convert your survey responses into numbers

For instance, if you have a question that reads "How likely are you to apply to university in the future?" the responses would be converted as below:

"Extremely likely" =7, "Likely" =6, "Somewhat likely" =5, "Neutral" =4, "Somewhat unlikely" =3, "Unlikely" =2, "Extremely unlikely" =1

## 3. Arrange your data

You will need to perform the test on each survey question individually. For ease, you can arrange the data as below so that the pre- and post-event scores for each question are next to each other. Whilst this isn't necessary, do at least make sure that each column is clearly labelled so that you don't get confused between questions when performing the test.

	Student ID	Pre: HE application	Post: HE application	Pre: post-16 study	Post: post-16 study	Pre: Self-efficacy HE applications	Post: Self-efficacy HE applications	Pre: Self-efficacy p entry
1								
2	1	4	6	4	4	2	4	
3	2	5	6	3	4	2	5	
4	3	5	7	5	4	2	4	
5	4	3	7	5	5	3	4	
6	5	6	7	4	5	3	4	
7	6	5	7	2	4	2	5	
8	7	7	7	3	3	4	5	

#### 4. Check that your data is normally distributed

A *t*-test can only be performed on data with a [normal distribution](#). A simple way to check this is by plotting a Histogram of your data. You can do this by using the 'Data Analysis' function (step 1) and selecting 'Histogram' from the list. As with performing the *t*-test, you will need to do this individually for each question. For the 'Input Range', select the pre-event scores for one of your survey items. The 'Bin Range' is the range of scores possible. In our case, this is 1-7 (as per the survey question in step 2 of this guidance). Create your 'Bin Range' by typing the numbers 1 to 7 in different cells in your spreadsheet. You can then select these cells for the 'Bin Range'. Make sure you tick the box which says 'Chart Output' then press 'OK'

Student ID	Pre: HE application	Post: HE application	Pre: post-16 study	Post: post-16 study	Pre: Self-efficacy HE applications	Post: Self-efficacy HE applications	Pre: Self-efficacy post-16 study	Post: Self-efficacy post-16 study
1	4	6	4	4	2	2	2	2
2	5	6	3	4	2	2	2	2
3	5	7	5	4	2	2	2	2
4	3	7	5	5	3	3	3	3
5	6	7	4	5	3	3	3	3
6	5	7	2	4	2	2	2	2
7	7	7	3	3	4	4	4	4
8	6	6	3	4	3	3	3	3
9	4	7	4	5	2	2	2	2
10	3	6	2	4	2	2	2	2

Bin range
1
2
3
4
5
6
7

**Histogram** ? X

Input

Input Range: \$B\$2:\$B\$11 ↑

Bin Range: \$F\$14:\$F\$20 ↑

Labels

Output options

Output Range: \$K\$11 ↑

New Worksheet Ply:

New Workbook

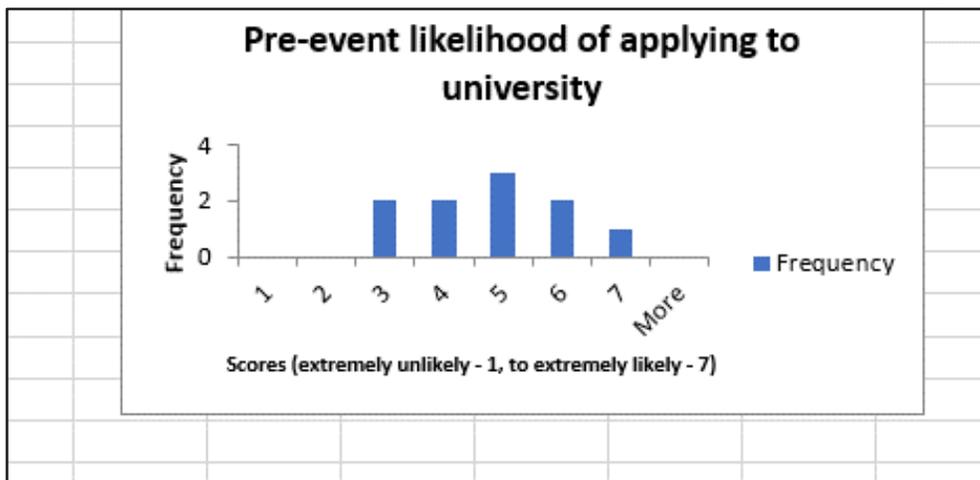
Pareto (sorted histogram)

Cumulative Percentage

Chart Output

OK Cancel Help

Your histogram will appear on a new sheet in your spreadsheet and look something like the below:



We can see from the histogram that our data is reasonably normally distributed (NB: it's unlikely to be a perfect bell curve especially with a small sample, but should be approximately normally distributed, with a peak in the middle and fairly symmetrical). If the data is non-normal (see this [site](#) for how to recognise non-normal distributions) you need to instead perform the [Wilcoxon Signed Rank test](#).

### 5. Perform the t-test

Select the 'Data Analysis' button under the 'Data' tab (see step 1). In the window that appears, scroll down to 't-Test: Paired Two Sample for Means' and press 'OK'.

For 'Variable 1 Range', select the pre-event scores for one of your survey items. For 'Variable 2 Range', do the same with the post-event scores. Including the column title will make interpretation of the results easier as the two means will be clearly labelled. Tick the 'Labels' box so that the column titles appear in the results. In 'Hypothesized Mean Difference', enter '0'. This value is the null hypothesis value, which is a default hypothesis stating that there will be no difference between the pre- and post-event mean scores. Excel uses a default Alpha value of 0.05 (the significance level) which you can leave as it is. Press 'OK'.

### 6. Interpreting the output

Your output will appear in a new sheet and look something like the below:

	Pre: HE application	Post: HE application
Mean	4.8	6.6
Variance	1.733333333	0.266666667
Observations	10	10
Pearson Correlation	0.196116135	
Hypothesized Mean Difference	0	
df	9	
t Stat	-4.323460153	
P(T<=t) one-tail	0.000961706	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.001923412	
t Critical two-tail	2.262157163	

By looking at the 'Mean', we can see that the average score for 'Likelihood of progressing to HE' before the summer school was 4.8, compared to 6.6 post-summer school.

The most important statistic in the output is the p-value. This tells you whether the difference in the means is statistically significant. Here we will look at the 'P(T<=t) one-tail' value which is the p-value for the one-tailed form of the test. This is because we are expecting there to be a difference in the means in one direction. Based on previous research, we expect that a student's likelihood of applying to HE will increase post-summer school, and therefore that the post-summer school mean score will be greater than the pre-summer school mean score.

Because our p-value (0.000962) is less than the standard significance level of 0.05 (alpha value), we can reject the null hypothesis, which states that there will be no difference between the pre- and post-event mean scores. Our sample data support the alternative hypothesis that the average score of self-reported likelihood of applying to HE was significantly greater post-summer school.

## 7. Calculating the effect size

When comparing pre-event and post-event scores, the effect size is the amount of gain measured in standard deviations. This is useful to calculate as you may have a statistically significant result, however, the actual effect size may only be small. We can see from the above step that the pre-summer school mean for this question was 4.8, whilst the post-summer school mean was 6.6, a difference of 1.8. This figure cannot be easily compared to other studies, however, which may use different scales to measure likelihood of applying to HE. To combat this, we compute the standard deviation gain by carrying out the below calculation:

$$\frac{\text{mean post event score} - \text{mean pre event score}}{\text{standard deviation of pre event scores}}$$

We know that the top line of this equation is 1.8. To calculate the standard deviation of the pre-event scores, type =STDEV.P into a cell in your excel sheet, then in brackets, select the pre-event scores for the question you are testing (e.g. =STDEV.P(B2:B11)), then press enter.

For this example, we would then carry out 1.8/1.2489996, which equals 1.44. This means that the post-event scores are nearly one and a half standard deviations greater than the pre-event scores.

The effect size is also known as Cohen's *d*, used to show the standard difference between two means. Below shows a general rule of thumb for interpreting Cohen's *d*:

- Small effect = 0.2
- Medium Effect = 0.5
- Large Effect = 0.8

1.44 is therefore considered to be a very large effect size.

## 8. Reporting the results

For each survey item, you will need to run the above analysis and report the results. You will report the mean pre-test score, the mean post-test score, the *t*-value (*t* statistic), the number of people in the analysis (*n*), the value of *p* (and whether it was one- or two-tailed), and the effect size. For our fictitious data, we would report the result in the following way:

Post-summer school scores for likelihood of applying to HE (*M* = 6.6) were higher than pre-summer school scores (*M* = 4.8). A paired samples t-test found this difference to be significant (*t* = -4.32, *n* = 10, one-tail *p* < 0.001). The effect size is 1.44 which means that the post-summer school scores are more than a standard deviation higher than the pre-summer school scores. This is considered a large effect size.